DEVELOPMENT OF

CONTINUOUS CARBON PAPER FACSIMILE RECORDER

FINAL REPORT

PERIOD COVERED:

12 January 1959 to 12 February 1963

Signal Corps Contract No: DA36-039 SC-78251
File No: 18538-PM-59-91 (6414)

U. S. Army
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

WESTREX CORPORATION
540 West 58th Street
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The object of this program is to design and construct eight engineering test models of a continuous carbon paper facsimile recorder for the reception of written, printed, or handwritten copy, maps, charts, and forms having a maximum width of 8-1/2 inches. The recorder is to be compatible with a continuous facsimile scanner developed under Signal Corps Technical Requirement SCL-1773 and other scanners having an index of cooperation of 264 and drum speed of 180 or 90 revolutions per minute.

The program was later expanded to include the modifications of three of the recorders with an index of cooperation of 576 at selective scan rates of 60, 90 and 120 scans per minute.

Signal Corps Contract No: DA36-039 SC-78251
File No: 18538-PM-59-91 (6414)

Signal Corps Technical Requirement: SCL-1771
17 November 1959

Report Prepared By:
Dr. H. Weisbecker
Project Manager

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

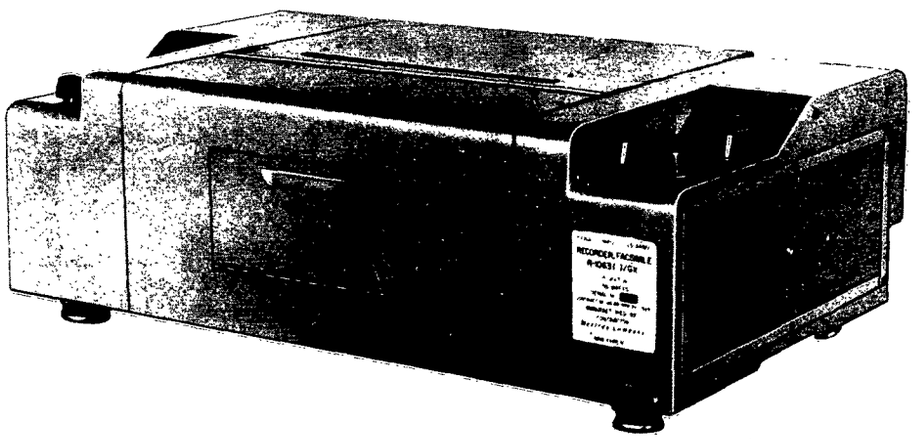


Figure 1. Carbon Paper Recorder R-1063( )/GX

I. PURPOSE.

To design, develop and produce a carbon paper type recorder with the capability of continuous reception of copy of printed or handwritten maps, charts, and forms having a maximum width of 8-1/2 inches. The recorder shall be compatible with a continuous facsimile scanner developed under Signal Corps Technical Requirement SCL-1773, and other scanners having an index of cooperation of 264 and a drum speed of 180 or 90 revolutions per minute. The recorder shall operate from a fixed installation with a nominal 117-volt, 60-cps power source and shall be capable of being installed and operated by unskilled personnel. (See figure 1.)

The scope was later broadened to include the modification of three of the recorders to provide an index of cooperation of 576 with optional selective scan rates of 60, 90, and 120 scans per minute in order to be compatible with standard weather map transmitters.

The task was to be accomplished in three major phases:

PHASE 1. - DESIGN PLAN: To devise a plan of design and formulate pertinent design and performance data to meet the requirements called for in the technical specification. The plan shall include equipment characteristics such as size, weight, and power drain, and shall be submitted to the contracting officer, or his representative, for approval.

PHASE 2. - ILLUSTRATIVE MODELS: To fabricate and supply five illustrative, full scale models to make manifest the overall size and shape of the units and the physical layout and function of controls, indicators, connections and other aspects relating to human engineering. The illustrative models to be delivered in August 1959. (See figure 6)

PHASE 3. - ENGINEERING TEST MODELS: To build, test, and deliver eight engineering models of the recorder in accordance with Signal Corps Technical Requirement SCL-1945, dated 22 January 1958: and to furnish overall photographs, instruction books, and spare parts list as provided for under the contract.

II. ABSTRACT.

This document constitutes the final report in a series of forty-eight monthly and quarterly progress reports covering the development of a continuous carbon paper facsimile recorder by the Westrex Corporation (formerly Times Facsimile Corp), a Division of Litton Industries Inc., located at 540 West 58th Street, New York City, under Signal Corps contract No. DA36-039 SC-78251, file No. 18538-PM-59-91 (6414).

The recorder, Model R-1063 ( )/GX, (Figure 1), is designed for fixed station use in the reception of both weather and message type information and is capable of reproducing copy sent from a remote point by accepting facsimile signals over wire or radio hook-up. (See figure 2). For the latter mode of operation, a receiver-converter is used. Operation is directly from a 115-volt, 60-cps power line. The present equipment is identical in circuit operation and method of recording with that developed under Signal Corps Contract No. DA36-039 SC-74836.

Set forth in the paragraphs following is a resume of the work performed and obstacles surmounted in completing the task assigned under the contract and spelled out under Section 1.- PURPOSE, this report.

PHASE 1. - DESIGNING PLAN APPROACH: Upon inception of the contract a study of the requirements and specifications cited was made by company management and an initial overall design was formulated. The problems evinced were analyzed and apportioned to the various engineering groups concerned for investigation and resolution. After separate group evaluation and research, the different engineering groups met in concert and an integrated design plan evolved which was presented to project management. This plan, after some reworking, became the basis for the complete design proposal which was submitted to the Signal Corps Contracting Officer and his representatives for review and final approval. It was agreed between company management and the Signal Corps Contracting Officer that the subject recorder design would closely parallel that used for the "Marine Recorder", which was being developed at that time by the company under Signal Corps Contract No. DA 36-039 SC-74836, and in addition be compatible with the Continuous Scanner being developed by the company under Signal Corps Technical Requirement No. SCL-1773 and other scanners having an index of cooperation of 264 and a drum speed of 90 or 180 rpm.

Operation Over Telephone Line, Block Diagram

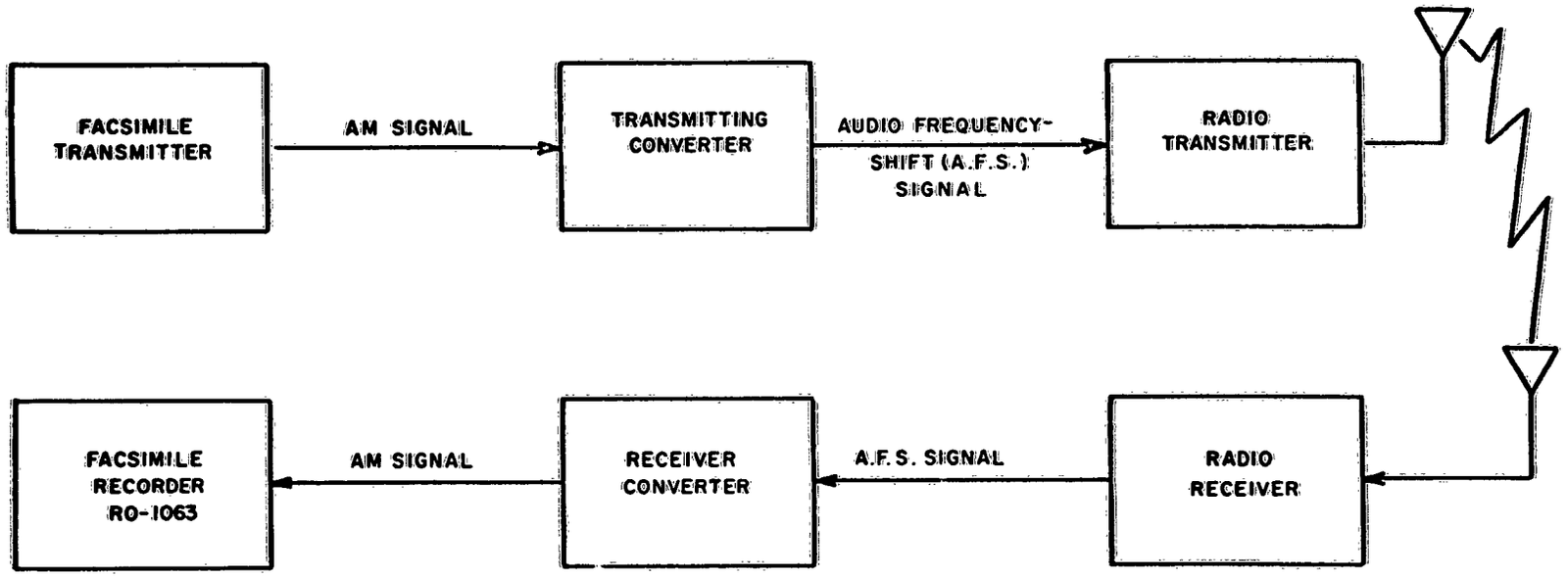


Figure 2. Operation Over Radio System, Block Diagram

PHASE 2. - ILLUSTRATIVE MODELS: Drawings were started and completed for the construction of the illustrative models in May 1959 and parts were ordered. During the month of June 1959 construction of the models began and continued throughout July. At the beginning of August the five illustrative models were delivered to the Signal Corps Laboratories for evaluation. Layout of the panel controls and the general physical size and shape of the console were approved and work progressed to the final design of the recorder.

PHASE 3. - ENGINEERING TEST MODELS: Work on the electrical and mechanical sections of the recorder proceeded once the overall design was firmed. The design was to follow closely that of the Marine Corps Recorder with modifications for 115 volts AC operation and provision for larger rolls of recording paper. During the first two years of development major effort was spent building and testing breadboard circuits, ironing out difficulties, and making final drawings. From July, 1960 to January, 1961 work was halted until further development of the Marine Corps Recorder, upon which the present recorder depended, was completed; however, testing and analysis of electrical and mechanical subassemblies still proceeded, and a summary of labor and materials necessary to complete the task was drawn up. Assembly of the first recorder was completed in April 1961 and tests completed in May the same year. Tests indicated a necessity of change in design of the rubber belt in order to maintain alignment of the printing unit and the recording paper. On June 20th 1961 a cost analysis was made and a request for additional funds was submitted to the Contracting Authority. From June to October, 1961, no work was scheduled pending re-negotiation of the contract. The first carbon paper recorder was completed, tested and sent to the Marine Corps for demonstration in March 1962, and met with considerable success. It was decided to modify the fourth recorder for weather type reception. A change in method of gear shift was made in the third recorder along with the modification for weather data reception. By July, 1962, the second and third recorders were completed, tested, and delivered. During September 1962, the fourth recorder, designed to receive both weather and message type data, and the fifth recorder for message data only, were completed, tested, and delivered. The technical manuals for the recorders were also completed during this period. The sixth and seventh recorders incorporating the original design, were delivered in November 1962; and in December, the same year, the eighth and final recorder was completed, tested, and delivered fulfilling the terms of the contract.

III. PUBLICATIONS, REPORTS, LECTURES, CONFERENCES.

During the course of the contract the following expository events took place:

a. PUBLICATIONS: - Instruction Manual No. 193-34-00-06 for the Carbon Paper Recorder R-1063 ( )/GX was published September, 1962, at Westrex Corporation, Litton Systems, Inc, 540 West 58th Street, New York 19, New York.

b. LECTURES: - A lecture, "Demonstration of the Model R-1063 ( )/GX, Carbon Paper Recorder", was held before the Marine Corps Board at Quantico, Virginia, in March 1962.

A lecture, "Demonstration of the Model R-1063 ( )/GX, Carbon Paper Recorder", was held at Marine Corps Head Quarters, Washington, DC, in May 1962. A lecture "Demonstration of the Model R-1063 ( )/GX, Carbon Paper Recorder", was held before the Combined Chiefs of Staff, NATO Headquarters, Paris France, July 1962.

c. REPORTS: - During the life of the contract the following reports were issued by the Company and submitted to the Signal Corps:

32 - Monthly Performance Summaries,

15 - Quarterly Reports, and

1 - Final Report, the present report.

d. CONFERENCES: - The following conferences were held throughout the life of the contract:

An initial conference was held at the Westrex Company Offices January 1959. Present were Mr. K.R. McConnel, Mr. A.E. Gruber, Mr. P. Marzan, Mr. A.G.Cooley, and Mr. P. Borish, all of Westrex Company, and Mr. J. Erhart, U.S. Army Signal Corps.

Subject discussed was the provisions of the contract DA36-039 SC-78251.

It was concluded that design of the present recorder should parallel that of the Marine Corps Recorder being developed under contract DA 36-039 SC-74836.

A conference was held to discuss the proposed change in design of the motor drive package. In attendance were Mr. K.R. McConnell, Mr. A.E. Gruber, Mr. S. Levine, and Mr. J. Vakarietis, all of Westrex Company, and Mr. J. Erhart of the U.S. Signal Corps Engineering Laboratories. The conference was held at the Westrex Company Laboratories, New York City. The proposed change was approved and it was agreed to use the Times Facsimile Corporation (now Westrex Company) designed GS motor drive package instead of the preliminary design motor start system.

An intra-staff conference was held at the Westrex Company Offices in October 1959. Present in attendance were Mr. A.G. Cooley, Mr. P. Marzan, Mr. K.R. McConnell, Mr. E. Lincoln, and Mr. J. Vakarietis. Subjects discussed were heat sink problems, motor drive system, phasing, and chassis layout problems. Preliminary design was revised and a chassis layout firmed.

On 20 June 1961 a telephone conference was held between Mr. K. R. McConnell, Mr. P. Borish, both of Westrex Company, and Mr. J. Erhart, Contract Representative of U.S. Army Signal Corps Engineering Laboratories. Discussed was a need for additional funds to complete development work. It was concluded that a cost analysis be made and a formal request for funds be made to the Signal Corps. This was done and re-negotiation of the contract commenced which resulted in final granting of additional funds.

IV. FACTUAL DATA.

Award of a contract for the development of the subject recorder was granted Westrex Corporation 12 January 1959 and a plan of action was immediately embarked upon to follow closely the three major phases of development specified under the contract and further spelled out in section I. - PURPOSE, of this report. Consequently during the month of January, the first month the contract was in force, a problem of familiarization with the technical requirements of the recorder as specified in the contract was instituted.

An overall design approach was established, a design processing flow chart drawn up, and the task was apportioned to the various engineering groups for detail analysis to reveal, as far as possible, any forthcoming engineering problems. (See figure 3, Engineering Project Processing Flow Chart). After study and investigation by the separate engineering groups, an integrated preliminary plan was devised and submitted to the Contracting Authority for approval.

Since technical requirements for this recorder closely paralled those specified for a facsimile system already under development for the Marine Corps under a prior contract No. DA 36-039 SC-74836, granted this company by the Signal Corps 13 June 1957, it was naturally decided that much of the design in the Marine Recorder could be incorporated into the present recorder. Therefore a design plan proposal was completed in February 1959 which specified that the electrical and mechanical designs used in the Marine Corps Recorder be revised and used in the present recorder. This proposal was discussed and approved at a meeting held with Company engineers and the Signal Corps Contracting Officer and his technical representatives. It was further agreed at this meeting that a self-starting synch motor be developed for this recorder and the original overall size estimate could be revised downward to 20-1/2" x 15" x 8" since a carbon paper take-up reel allowed for the original design was not needed.

During the period from March to April 1959, the overall mechanical unit design was completed which included design of the band tension and idler pulley support mechanisms, the phasing, copy feed gear train, paper thread and feed mechanisms, and a modified Marine Corps Recorder trolley and track rail. (See figure 4 and 5). Preliminary design for a new phase mechanism was also studied at this time.

During the May-June period of 1959, detail and subassembly drawings of the mechanical unit were started, and it was decided that the design for the phasing mechanism would be modeled after the Marine Corps Recorder phase mechanism. Drawings for the illustrative mock-up models were completed and construction of the models started. An alternate dual start motor system was put under test to prevent possible delay in the completion of the first recorder in the event heat dissipation problems prolonged development of the self-starting sync motor. These tests brought about the decision to use a dual start motor as the preferred system and continue development of the self-start as alternate.

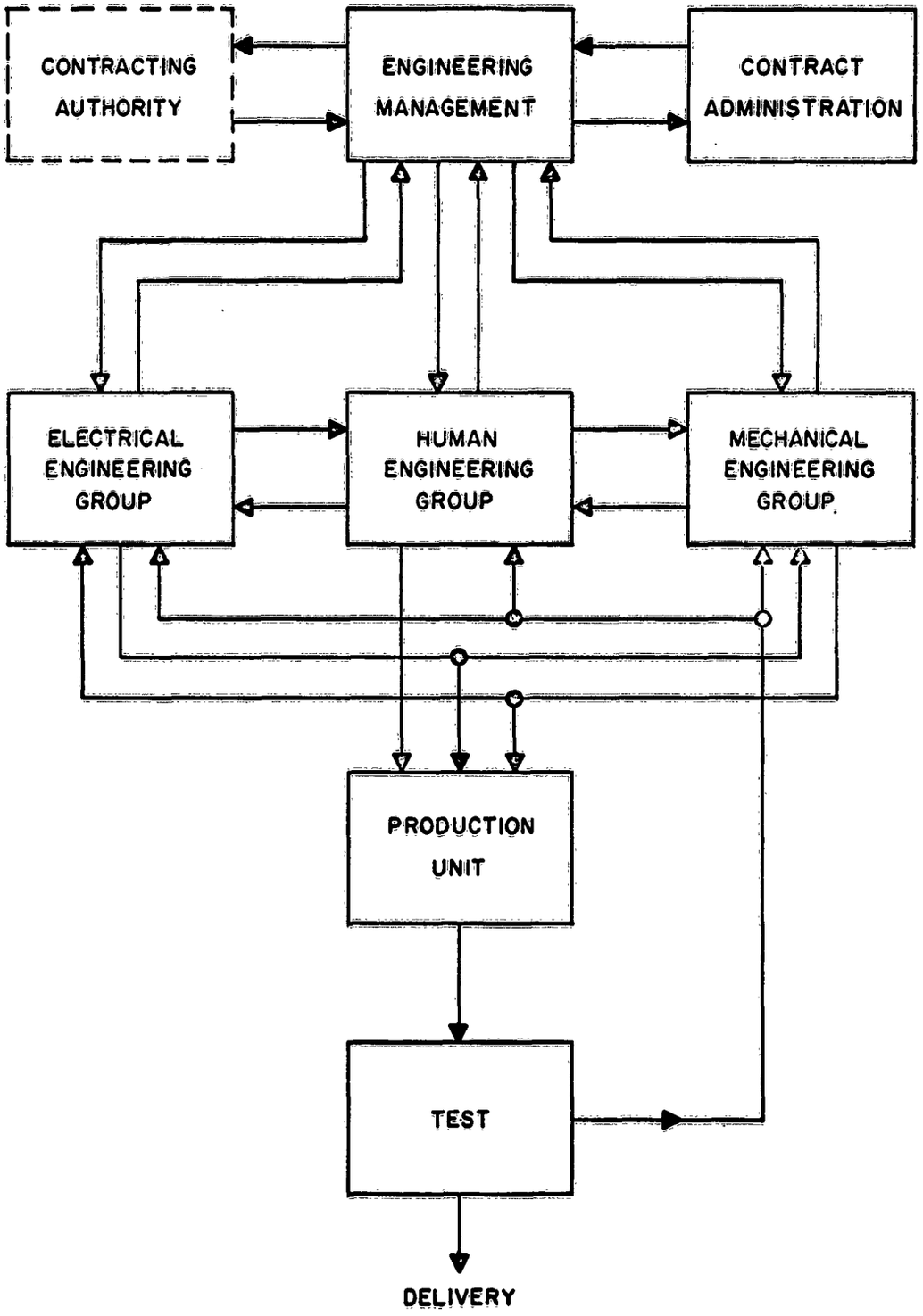


Figure 3. Engineering Project Processing Flow Chart

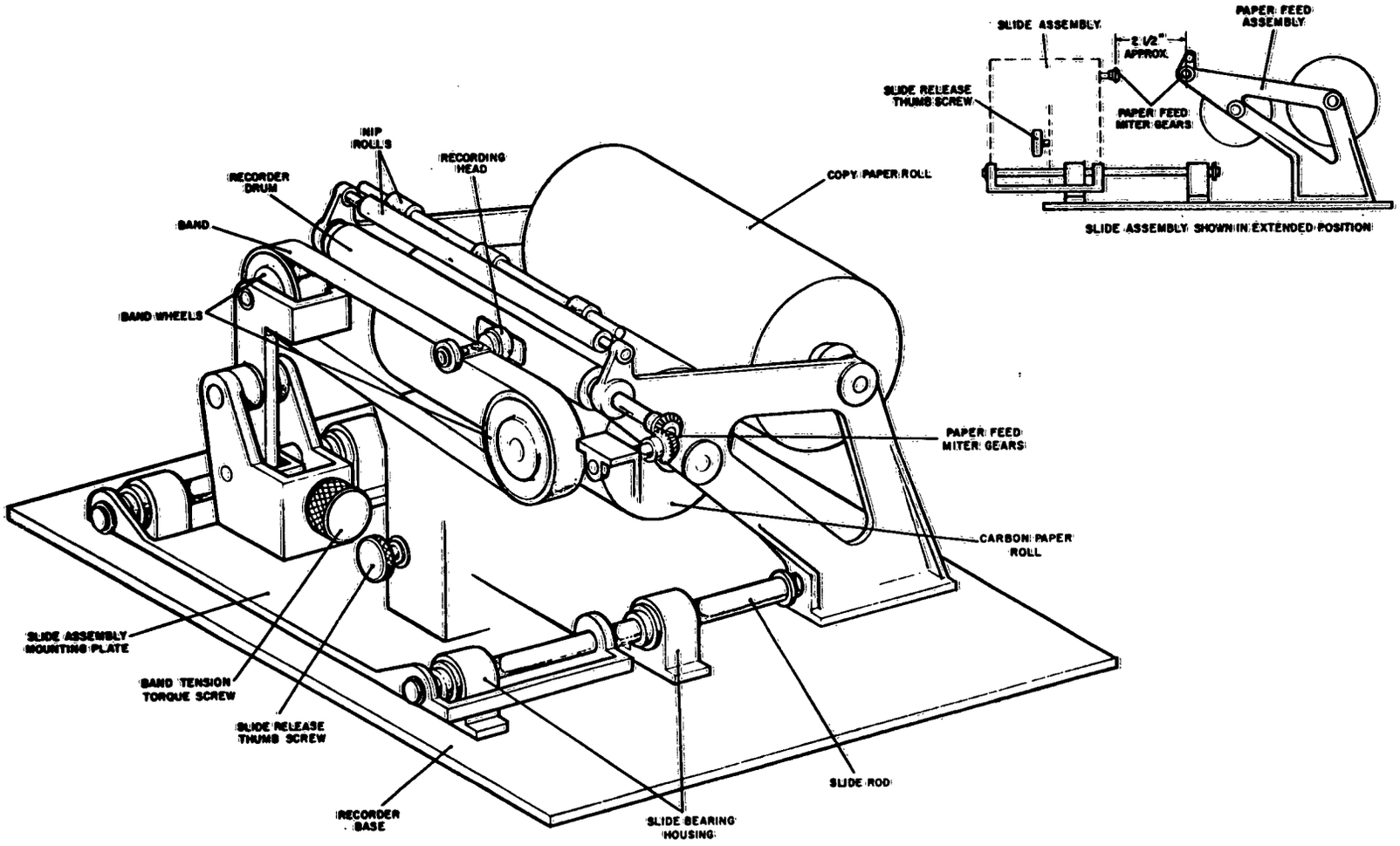


Figure 4. Redesigned Mechanical Unit, Pictorial Outline

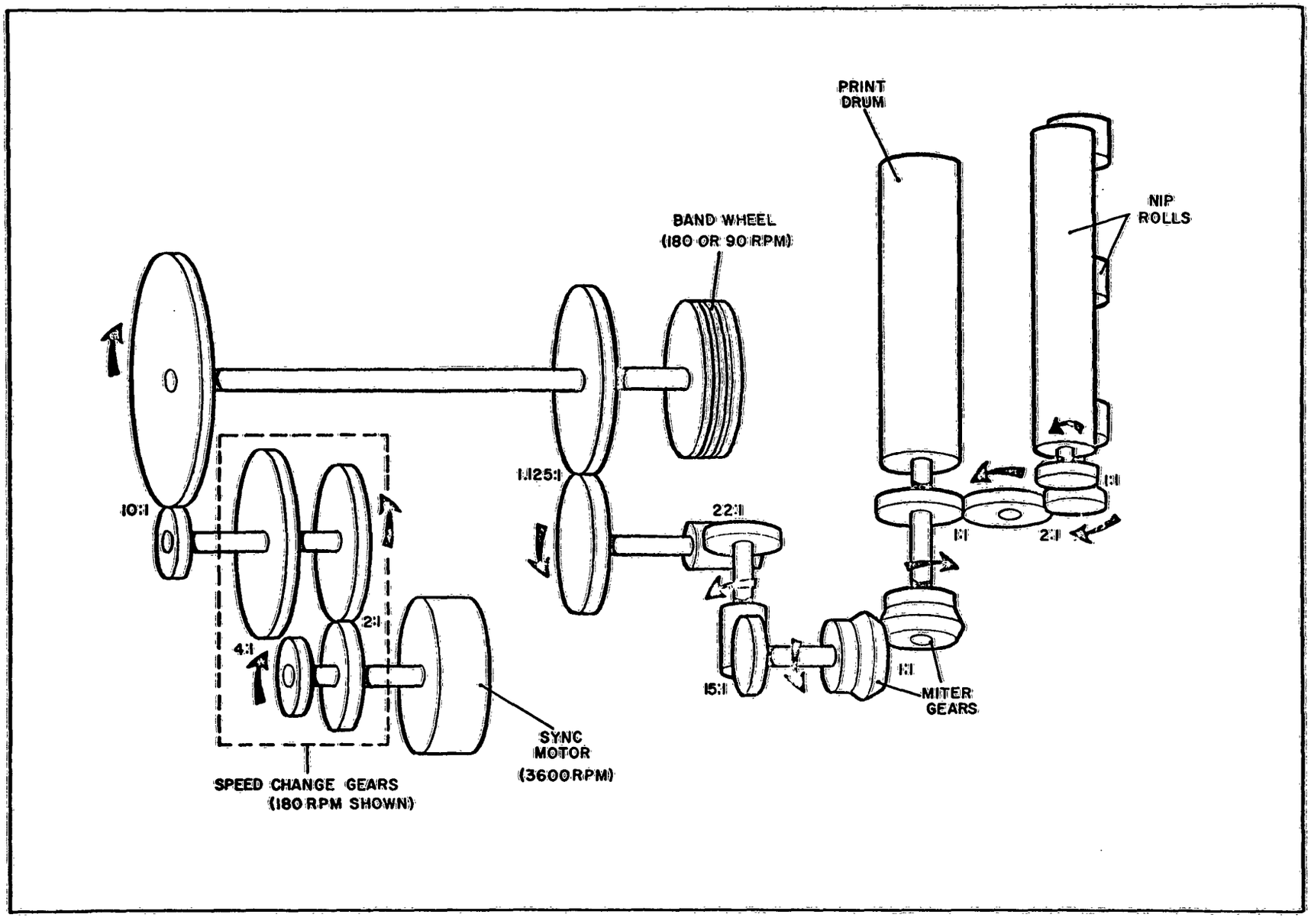


Figure 5. Redesigned Gear Train, Schematic Diagram

Minor revisions had to be made in the size and shape of the proposed recorder, and layout plans and detailing were completed based on this change in design. Construction of the housings for the five illustrative models were completed and component parts were ordered to finish the mock-up.

July-August 1959: - The five illustrative models were completed and shipped on schedule. (See figure 6). Printed circuit boards were 90% completed and awaited remaining components ordered. Tentative layout plans for printed circuit board placement were decided upon. Samples of power supply and filter chokes were ordered.

August - Sept 1959: - Layout plans for printed circuit board placement and chassis interconnections completed. Bread board tests of the regulated power supply brought out heat dissipation problems. It was decided a heat sink should be used to dissipate the heat from the series regulator transistor and a study was initiated as to the method of mounting the heat sink.

September-October 1959: - The final layout design of the electrical chassis was agreed upon. (See figure 7, 8, and 9). Two printed circuit boards associated with the right hand control switches were to be mounted on the right of the mechanical unit; three printed circuit boards were to be mounted to a chassis containing the power supply on the left side. Both chassis were to be removable without turning the recorder bottom side up. The reworked power supply bread board was completed containing all the parts proposed for use in the final equipment. Heat tests were planned. A 50 ohm resistor was added in series with the trolley from the print transistor collector to reduce the knock in the sync motor. This limits the print current but not enough to affect copy. Mechanical design details were completed and released for reproduction.

October - December 1959: - Assembly of the mechanical unit proceeded as ordered components were received. Difficulty in stability of binary dividers of the sync motor circuit arose due to triggering by stray noise pulses. Several solutions for this problem were formulated and additional work on the fork oscillator was performed.

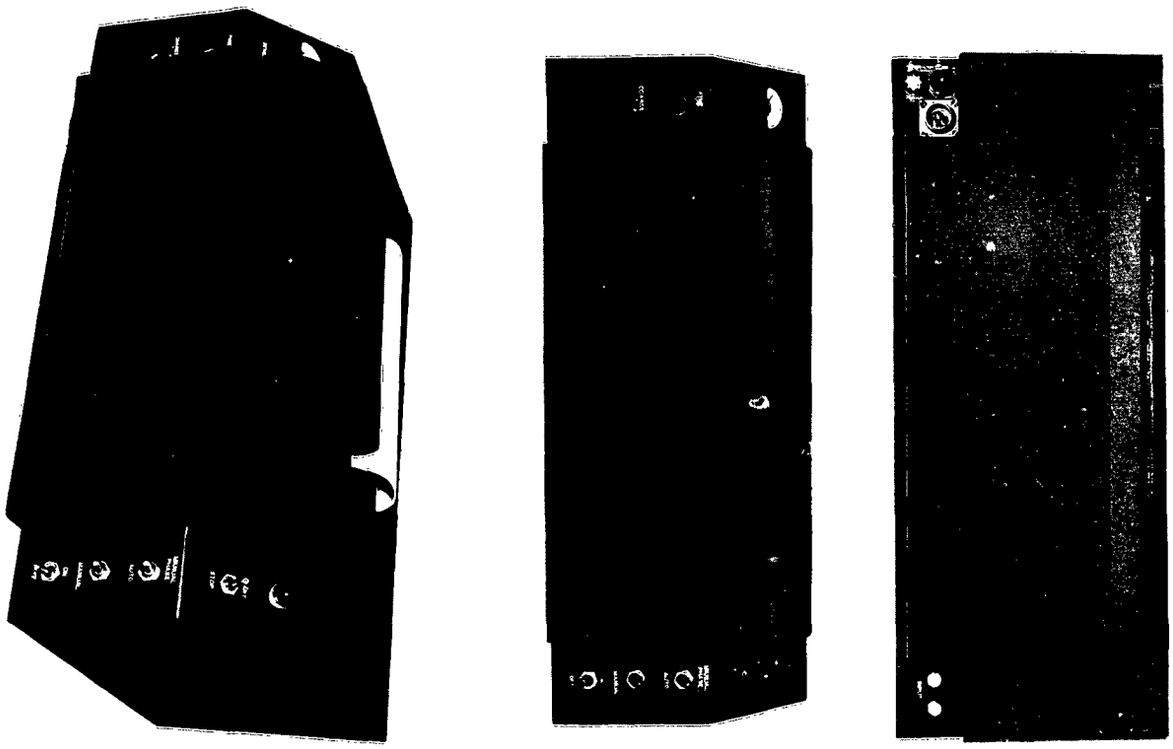


Figure 6. Illustrative Model, Continuous Carbon Paper Facsimile Recorder

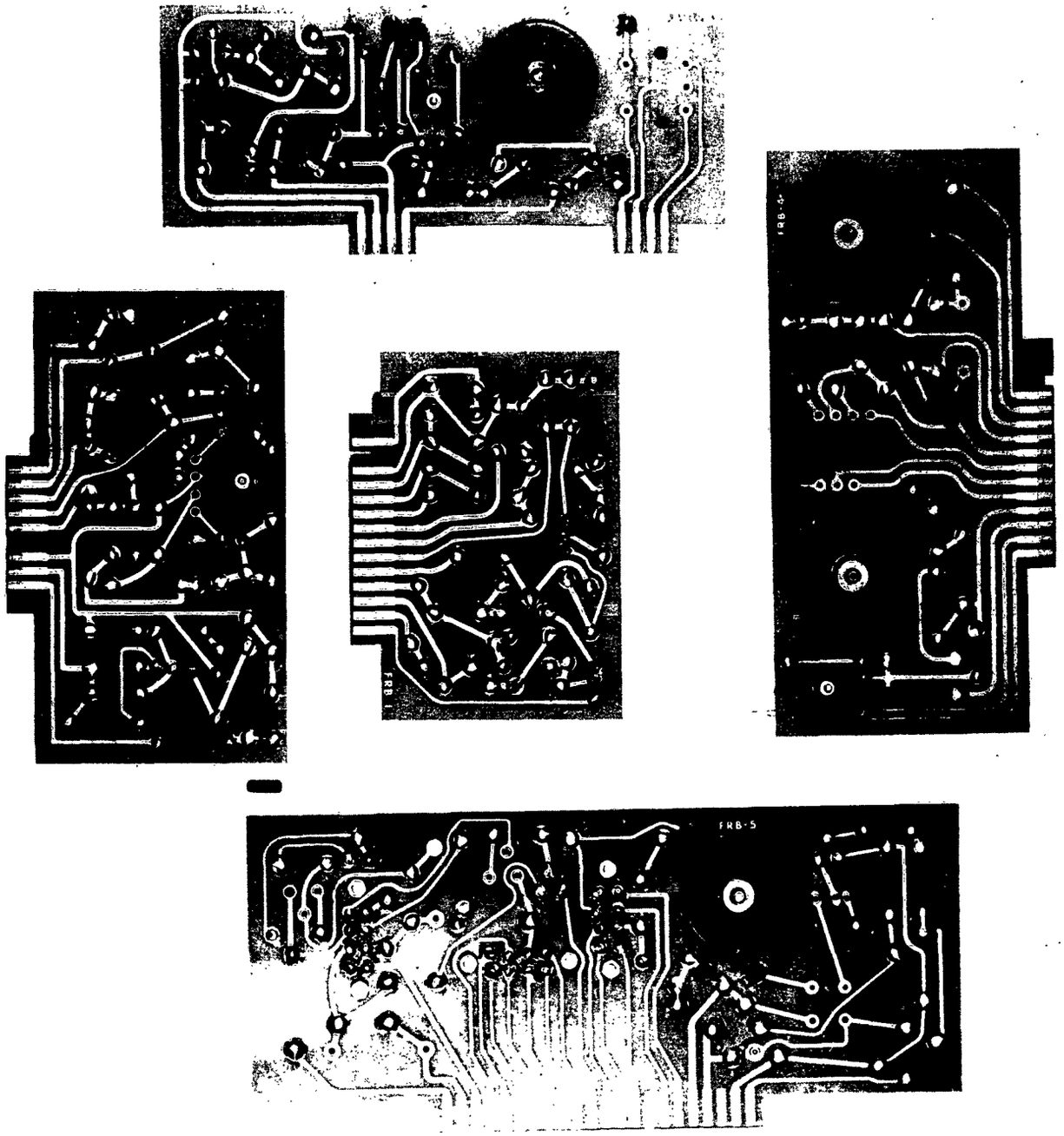


Figure 7. Bottom View - Prototype Transistorized Printed Circuit Plug-in Cards

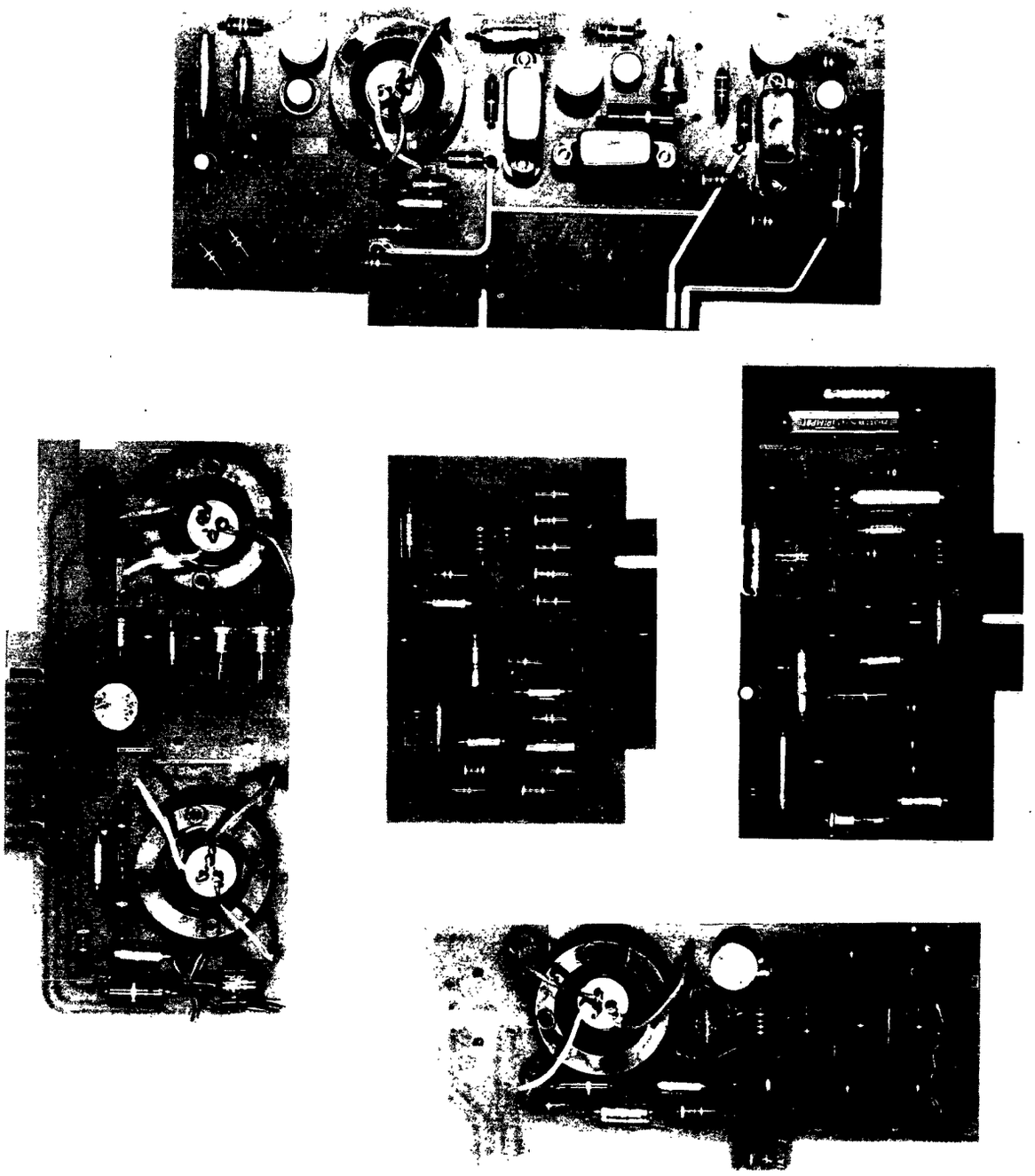


Figure 8. Top View - Prototype Transistorized Printed Circuit Plug-in Cards

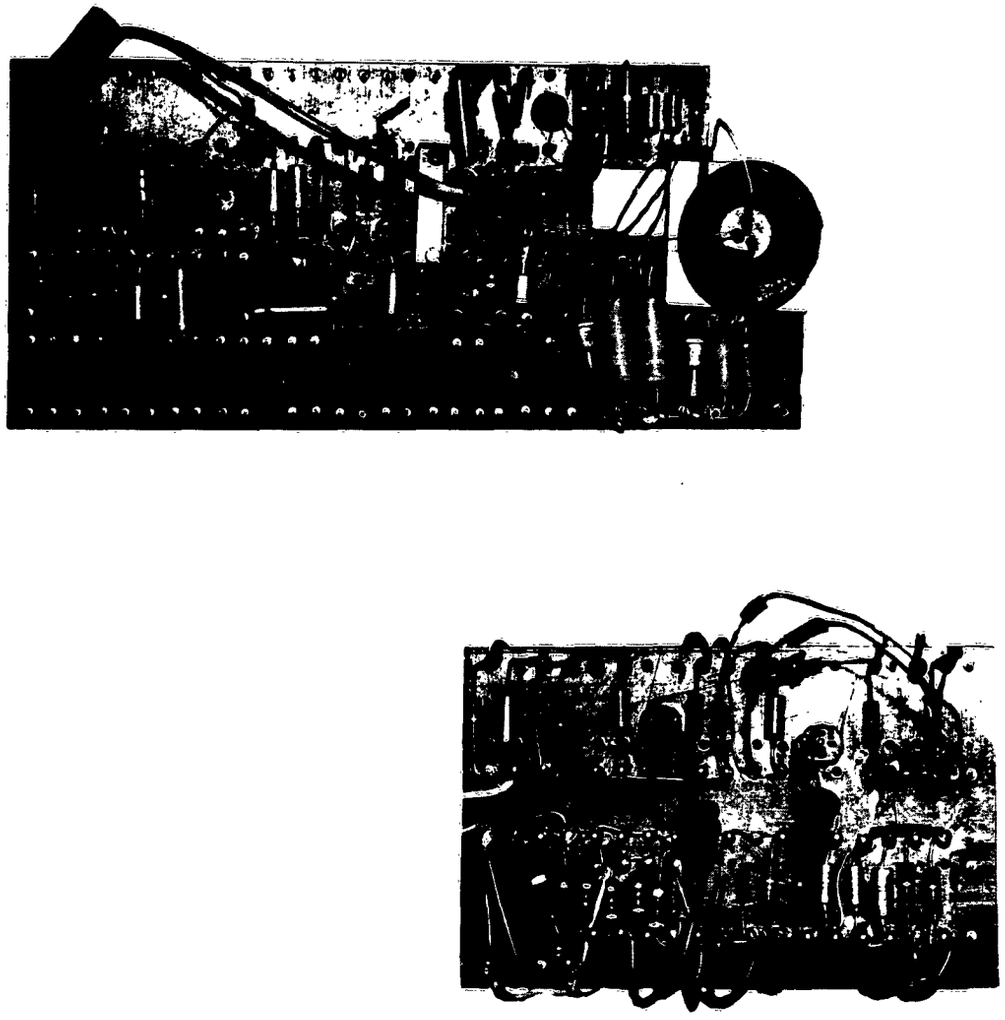


Figure 9. Prototype Models, Transistorized Terminal Boards

January - February 1960: - Commercial components were ordered during this period and deliveries were proceeding on schedule. Work on subassemblies and the final assembly progressed as parts were received. Experimental work on the sync motor indicated that by stacking more iron within the existing casing, greater output torque for a given DC current was possible. This increased the efficiency by about 30%. It was decided that rotor and stator cores be epoxy compression bonded and additional work be done to reduce iron and copper losses.

March - April 1960: - Subassembly parts which were sent out for plating, according to Mil Specs, were returned from the platers and initial assembly began. The experimental laboratory proceeded with final assembly. Additional engineering was done to adapt the design for time-belt type stylus bands. Stators and rotors for the redesigned sync motors were epoxy bonded and the rotors were sent out for assembling on the shafts and ground to size. Upon completion of the mechanical unit assemblies, tests of the sync motor and phase clutch with the bread board electronics were made. During test the 2N174 germanium transistors failed. Investigation revealed these transistors to be highly vulnerable to accidental "puncturing". It was decided to use silicon controlled rectifiers for the motor drive. As a result of these tests it was decided also to remove the motor circuit from the B+ regulator and put it on unregulated B+. This change resulted in resolving the heat problem which previously existed in the regulator, and the series transistor stud barely showed any sensible heat to the touch. Work on the final assembly of the mechanical units was held in abeyance pending completion of evaluation tests which were conducted during this period on the rubber type belts.

April - May 1960: - During testing of the motor drive circuit it was found that the silicon controlled rectifier would be damaged if the gate were overdriven. It was decided that this gate circuit must be clamped and very carefully driven to prevent overheating at the junction. Closer matching of the motor was provided by adding more turns to the motor coils, this was necessary to prevent overheating of the motor and to improve operating reliability of the inverter. Tests of the power supplies to contract specifications were conducted and indicated that future work was needed.

June-July 1960: - During this period, experimental work was done on a transistorized drive for a hysteresis two-phase motor. It was center tapped windings which may be operated directly from the 2N174 transistors without a coupling transformer.

The 300 cps frequency is obtained from a 2400 cps fork by three binary dividers in cascade. Another circuit was developed to operate in conjunction with the motor drive, which will accept the 300 cps output of the binary dividers and multiply it to 900 cps to drive the MS synchronous motor. Further evaluation of power supplies was carried on. Temperature tests on the signal amplifier circuitry indicated that, for our purposes, germanium transistors possessed certain inherent instability. To overcome this inadequacy, silicon transistors were substituted thus enabling an increase in the ambient temperature range. Since this project is, for all practical purposes, parallel to part of contract No. DA36-039 SC-74836, conclusions drawn from the development of the Marine Corps Recorder would affect the design of the equipment under the present contract; therefore little direct work was done on this recorder during this period awaiting the outcome of the Marine Recorder.

August - September 1960: - Major work on the recorder still in abeyance awaiting further completion of the Marine Recorder during this period; however research on some electrical circuit and mechanical unit problems continued. Consideration was given to redesigning the phase clutch and latch mechanisms with the idea in mind of reducing extraneous noises and increasing the durability of the latch. In the existing design, the latch clicked audibly once per scan. By combining the phase armature and latch, the latch would be lifted free on each revolution. Additional work was done on the design of the left side chassis. The plans call for a shallow chassis mounted by screws on studs above the base frame. (See figure 10 and 11). Printed circuit boards will be readily removable for servicing without the necessity of removing the covers. The input transformer, level controls, and the emitter follower will be packaged as a plug-in subassembly. The fork oscillator circuitry will be packaged in the thermally insulated fork casing thus eliminating one circuit board.

October - December 1960: - No further work was scheduled on the project during this period, awaiting further progress in the development of the Marine Recorder.

January - April 1961: - Defects discovered in the Marine Recorder being developed under contract No. DA36-039 SC-74836 were eliminated. This allowed work on the present recorder to resume development. Design work on the power supplies was completed, the motor was installed, and the mechanical parts required for mounting the electronics were designed and fabricated. The first Carbon Paper Recorder was assembled and tested during this period.

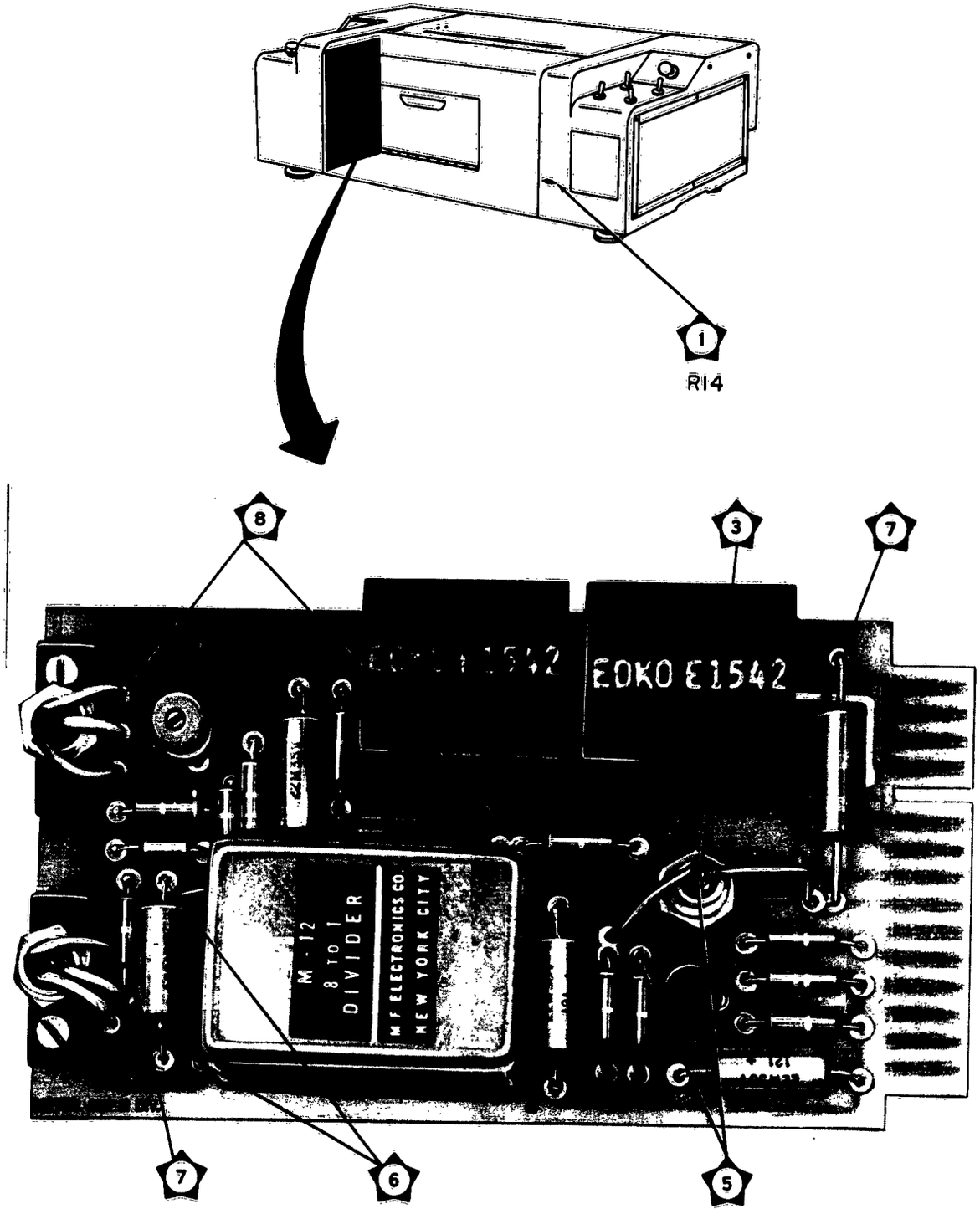


Figure 10. Carbon Paper Recorder R-1063( )/GX Test Point Location, Motor Amplifier and Divider Circuits

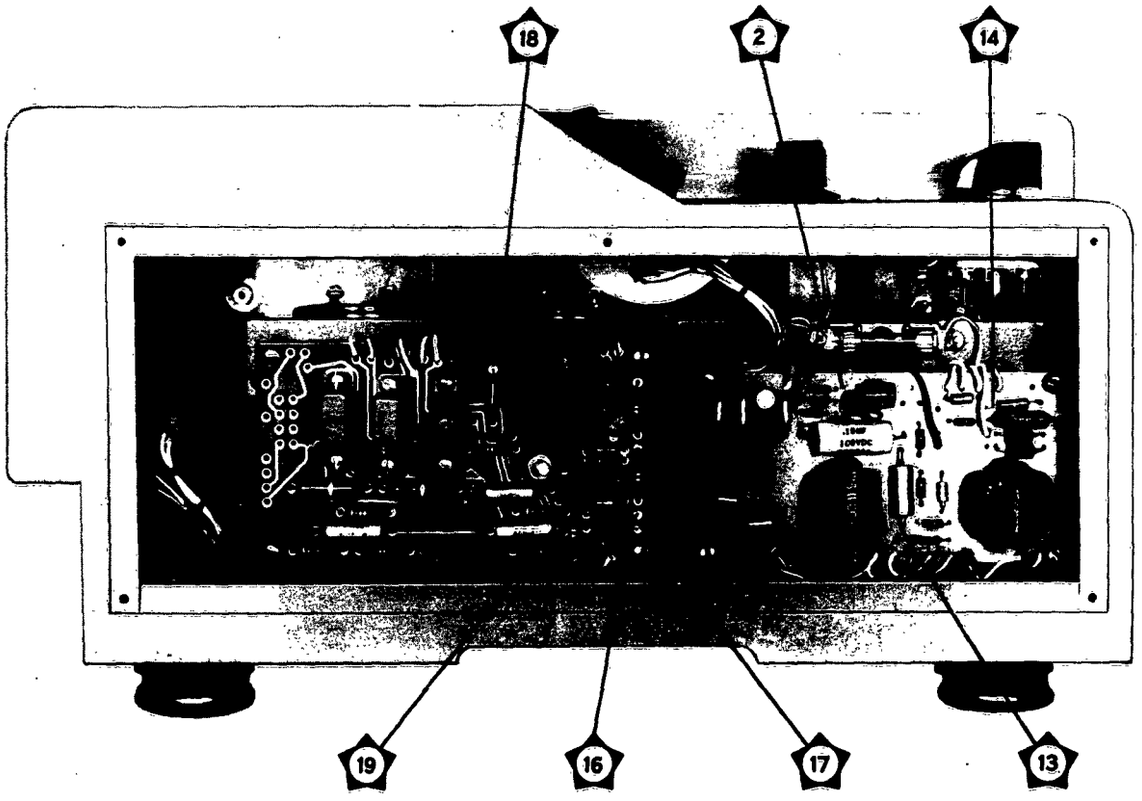


Figure 11. Carbon Paper Recorder R-1063( )/GX Test Point Location, Power Supply Circuits

May - June 1961: Initial testing of the first Carbon Paper Recorder indicated that a change in the mechanism holding the rubber belt was necessary to maintain the alignment of the printing unit and the recording paper. Several solutions to the problem were considered and the final design agreed upon incorporated a modified guide system using the rubber belt consisting of new guide bars, heads, rollers, and wheels. (See figure 12). On June 20th the Company provided the Contracting Officer with additional detailed information supporting Westrex estimates of the amount of new funds needed to complete this project. Work was temporarily suspended on June 29th pending re-negotiation of the contract.

July - October 1961: - No work was scheduled during this period pending re-negotiation of the contract.

November - 1961 - March 1962: - Electronic work was completed on the first unit, and a set of drawings were made for construction of the remaining units. The mechanical portions of the first, were delayed completion during this time while waiting for a band to be fabricated, following manufacture of a similar band for the Marine Recorder. During the latter part of this period of the first Carbon Paper Recorder was completed and sent to the Marine Corps for demonstration, where it met with success. Work proceeded on the production of the second recorder. Design work was also in progress for modification of some of the recorders for acceptance of weather data.

April - May 1962: - The mechanical units for the second and third carbon recorders were assembled. It was anticipated that during the month of May both these units would be completed. The second unit was to be identical with the first recorder already shipped. The third recorder was to be modified to accept weather maps as well as copy sent under the message standards. Motor speed changes were to be accomplished electronically with front panel control, and the change in index of cooperation was to be made by moving gears in the paper-feed mechanism. This was accomplished in the third recorder. Work remaining on the second recorder consisted, at this time, primarily of testing. On the third recorder, the electronic speed changing and sense changing circuits were tested and evaluated in final form.

June - July 1962: - Both the second and third recorders were completed and tested, and delivery was made to the Signal Corps. The second unit performed according to the original specifications. The third recorder was modified to operate on weather maps as well as in message service. The fourth recorder near completion; only the assembly of the mechanical unit remained. It was expected that the fourth unit would be delivered in August.

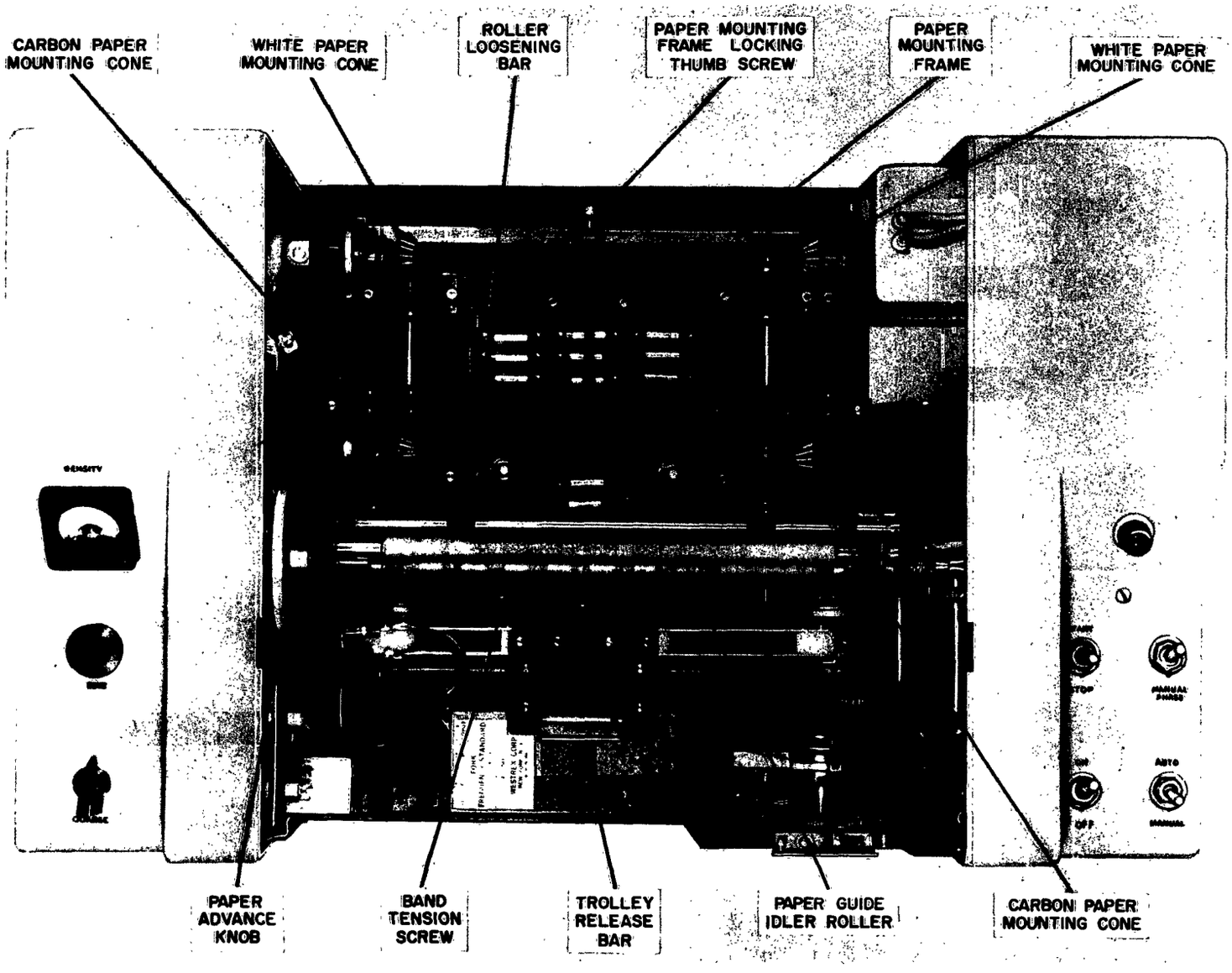


Figure 12. Carbon Paper Recorder R-1063( )/GX, Location of Mechanical Parts

August - September 1962: - Work on the fourth recorder, which was to be made to the original design, was held up in order to rush completion of the fifth recorder, which was to be modified to operate on both weather and message service. This modified recorder was completed and delivered, and the fourth recorder to the original design was delivered a few days later. The mechanical unit of the sixth recorder was now being built. The technical manuals for the recorder model were completed during this period.

October - December 1962: - During this period, the sixth and seventh recorders, both made to the original design, and the eighth recorder, made to accept both weather and message data, were assembled, tested and delivered. Delivery of the eighth and last recorder completed the task required in the contract.

The recorder in its final form fully meets all requirements of the specification. Detailed circuit functions are given in the Instruction Manual furnished with the equipment and, therefore, are not repeated here. A brief description of the operation follows. (Refer to figure 14, Schematic Diagram).

When the recorder is initially switched "ON", phasing signals are received from the transmitter for 15 seconds to allow the recorder to come into phase with the copy at the transmitter. At the end of the 15-second phasing period, the recorder starts its record cycle and the transmitter begins to scan the copy and transmit facsimile signals which the recorder receives.

A carrier detector in the recorder detects the presence of the facsimile signals sent from the transmitter and causes the recording band to move. Phasing pulses from the transmitter operate a phasing solenoid in the recorder for ten seconds to bring the recorder into phase with the transmitter. After the ten seconds the phase solenoid is locked in and printing begins. The print heads mounted on the band receive print current which causes a plunger to apply pressure to a carbon overlay and mark the white paper behind the overlay. Twenty seconds after the conclusion of the transmission, the carrier detector reacts to the absence of carrier, and causes the band to stop and the paper to cease feeding. Three print heads are mounted on the band to provide scanning at the rate of 180 lines per minute (or 90 with an adjustment). The diameter of the smallest reproducible detail is 0.01 inch. Representative samples of copy obtainable with this recorder are included in this report. (See figure 13).

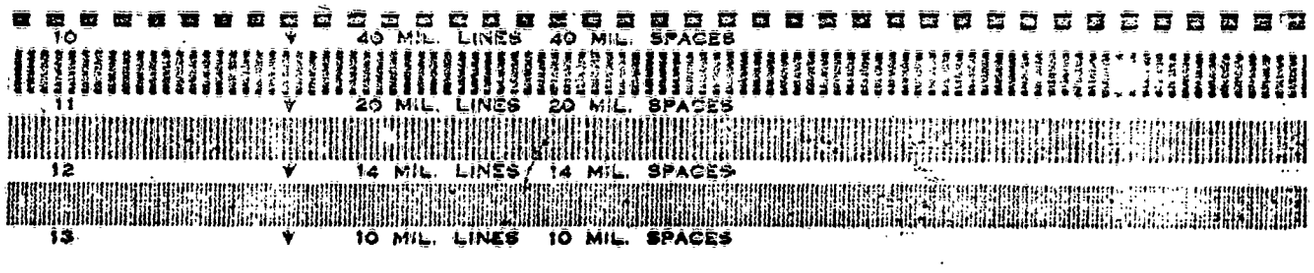


Figure 13. Sample Copy

The circuits used consist of a coarse and a fine attenuator, followed by a three transistor preamplifier and a power transistor driving a full-wave detector. Output from the detector is filtered and applied to a Darlington type output stage. Up to 250-ma peak current can be made to flow in the print head coils. The schematic diagram for the recorder is shown in figure 14.

A development going beyond that for the Marine Corps Portable Facsimile System is the design of a three-speed recorder. This recorder operates on three scan rates: 60, 90, and 120, with an index of cooperation 576, as well as in the original manner of 90 or 180 scans per minute, with an index of cooperation of 264.

The speed change is accomplished entirely electronically. Only the paper feed rate is changed mechanically. The latter is a very simple operation.

The above modification, made to date on three out of the eight recorders, enables the recorder to accept, not only graphical material, transmitted with message facsimile standards, but also weather maps transmitted on standards employed for these maps.

V. OVERALL CONCLUSIONS.

The work on this project has resulted in a fully developed recorder ready for field operation. The R-1063 ( )/GX Carbon Paper Recorder is the most advanced equipment of its kind employing the latest recording technique. The unit is extremely versatile in its operation. It may be employed for the reception of message traffic and all other types of graphic traffic from compatible transmitters having scan speeds of 90 or 180 scans per minute having an index of cooperation 264. The recorder can be used with transmitters having an index of cooperation 576 with scan rates of 60, 90, and 120 scans per minute which provides compatibility with present standard weather map transmitters.

The R-1063 ( )/GX recorder is simple to operate and very efficient in performance. The recording medium provided costs about twenty-five (25%) less than wet paper and about two-hundred and fifty percent (250%) less than electrosensitive paper.

Carbon paper recording gives very low cost copies which are wrinkle-free, require no drying and can be stored indefinitely without being affected by climatic conditions. Recordings can be made so multiple copies may be reproduced with any of the well known duplicating processes. Transparencies can be made for overlays, projection purposes, or for any other copying process which requires this type of original. Any combination paper and carbon paper is possible in emergencies in the field.

The Carbon Paper Recorder R-1063 ( )/GX has proven its reliability in performing unattended for long periods on a twenty-four (24) hour day basis. The inherent reliability of the recorder is high in comparison with the equipments it will replace on the basis of the use of silicon transistorized circuits, the rubber recording belt, and other advanced design features.

The program under contract No. DA36-039 SC-78251 has resulted in a versatile, compact recorder with extreme reliability having an index of cooperation of 264 at 90 or 180 scans per minute and an index of cooperation of 576 at 60, 90, and 120 scans per minute.

VI. RECOMMENDATIONS.

Areas in which further development could be carried out to achieve a more refined equipment are:

1. Improved design of print heads for ease of manufacture.

2. Operation of the sync motor of the recorder under control of the carrier detector to stop the motor automatically between transmissions.

3. Elimination of some transistors from the fork oscillator and amplifier circuits.

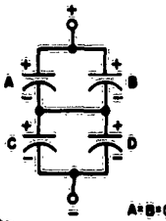
4. A value engineering program for the lowest manufacturing cost consistent with equipment performance and reliability standards.

VII. TECHNICAL PERSONNEL

Dr. H. Weisbecker	Project Manager
R. M. Jenifer	Project Manager
H. J. Dwyer	Electronic Engineer
J. Vakarietis	Mechanical Engineer
R. W. Fritsche	Electrical Designer
S. Kowal	Technician
A.G. Cooley	Technical Director
K. R. McConnell	Director of Facsimile Engineering
P. R. Marzan	Supervisor of Electrical Engineering

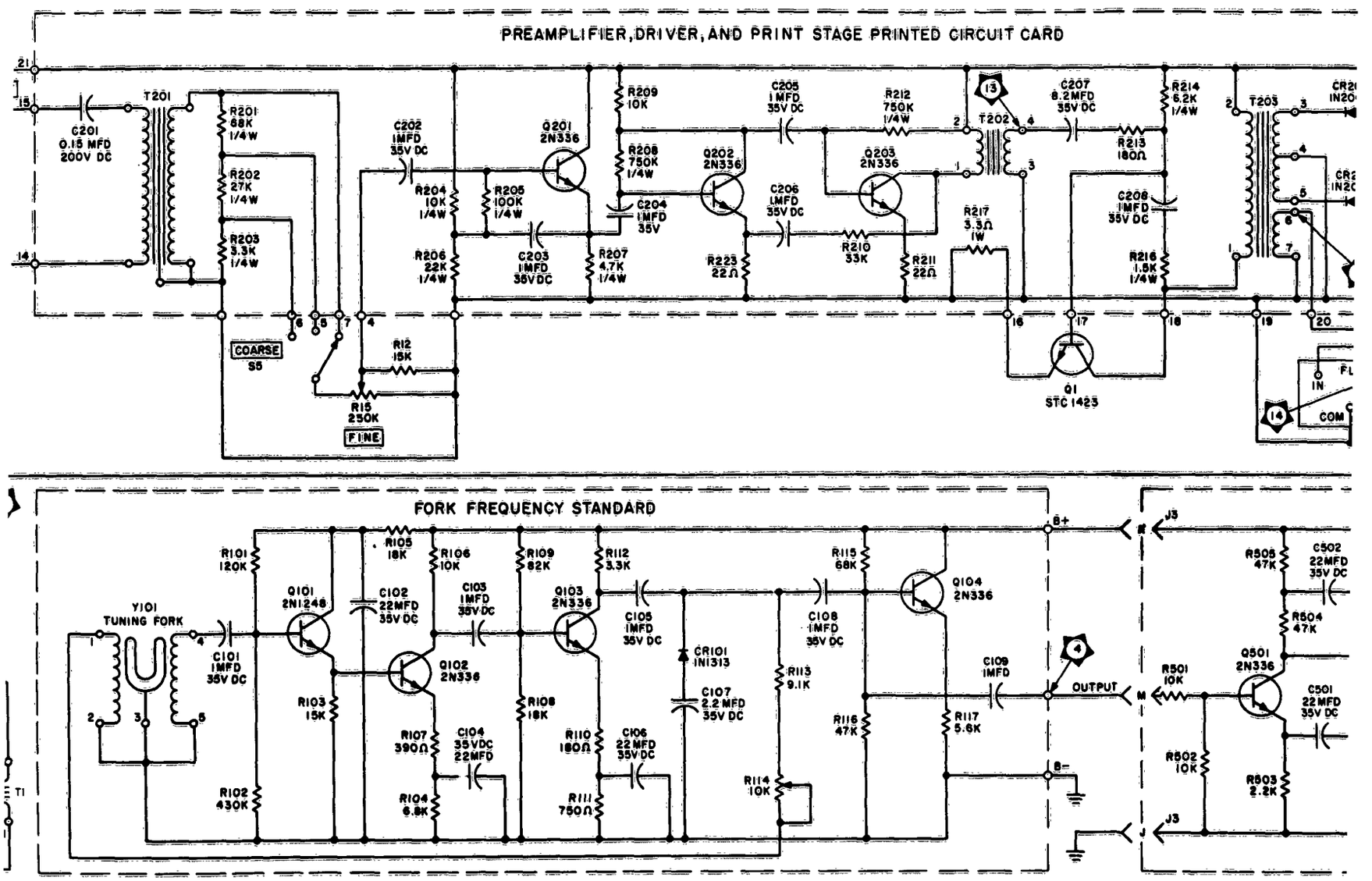
NOTES:

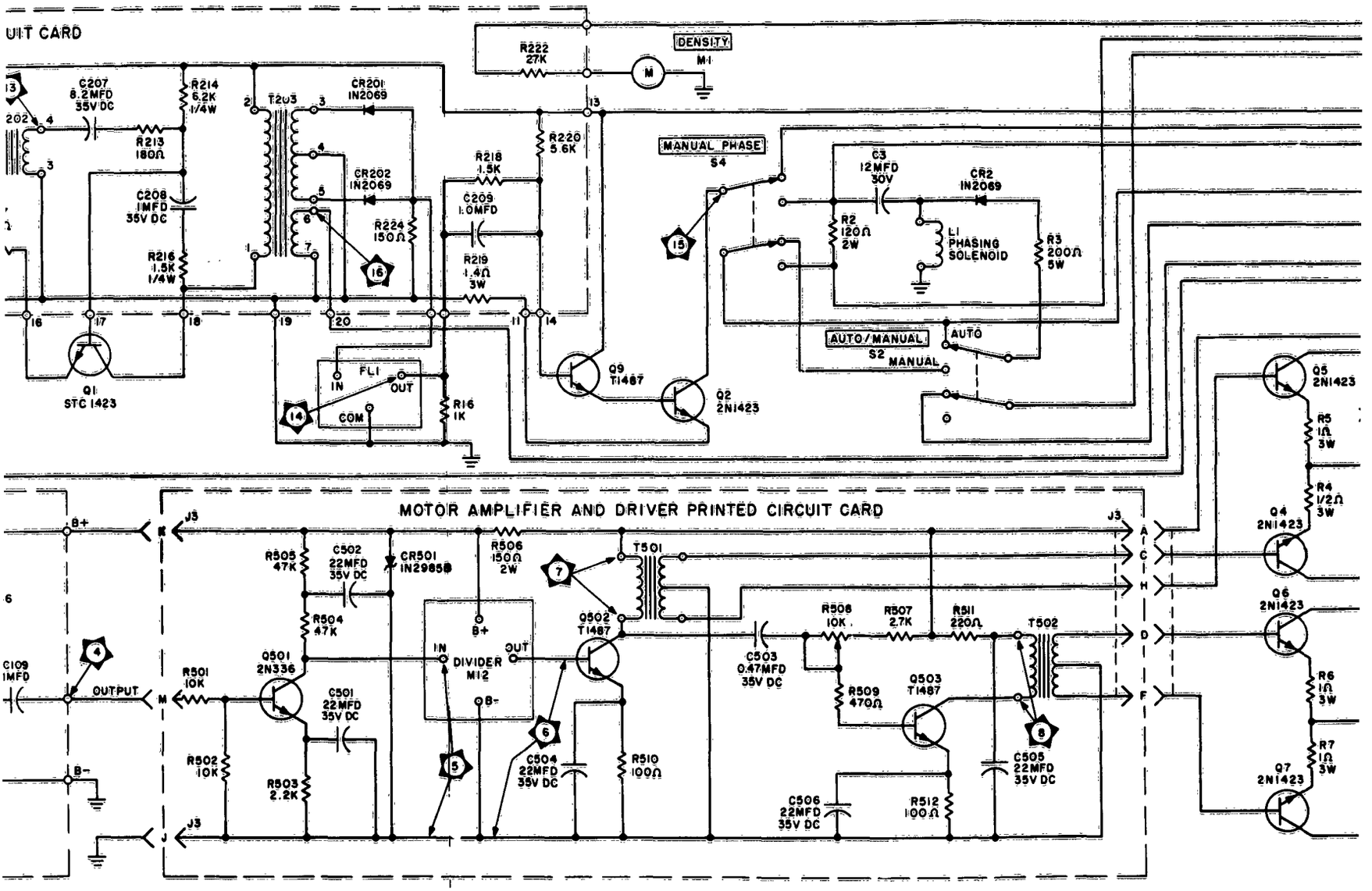
1. ALL RELAYS SHOWN IN DEENERGIZED POSITION.
2. ALL RESISTORS 1/2W UNLESS OTHERWISE SPECIFIED.
3. WITH THE INPUT SHORTED, THE VOLTAGE DROP ACROSS:
   a) R47 SHOULD BE 0.43V DC.
   b) R219 SHOULD BE 0.32V DC.
4. CAPACITORS C4, C5, C6, C7 ARE EFFECTIVELY 47MFD EACH AND IS COMPOSED OF THE FOUR CAPACITOR NETWORK SHOWN BELOW:



A=B=C=D=47MFD-35V DC.

5. ⬠ INDICATES TEST POINT.


PREAMPLIFIER, DRIVER, AND PRINT STAGE PRINTED CIRCUIT CARD
C201 0.15 MFD 200V DC
T201
R201 68K 1/4W
R202 27K 1/4W
R203 3.3K 1/4W
COARSE S5
R12 15K
R15 250K FINE
C202 1MFD 35V DC
R204 10K 1/4W
R205 100K 1/4W
R206 22K 1/4W
C203 1MFD 35V DC
Q201 2N336
R209 10K
R208 750K 1/4W
C204 1MFD 35V
R207 4.7K 1/4W
Q202 2N336
R223 22Ω
C205 1 MFD 35V DC
C206 1MFD 35V DC
R212 750K 1/4W
Q203 2N336
R210 33K
R211 22Ω
T202
C207 8.2MFD 35V DC
R213 180Ω
R214 6.2K 1/4W
R217 3.3Ω 1W
C208 1MFD 35V DC
R216 1.5K 1/4W
T203
Q1 STC 1423
IN
COM
FORK FREQUENCY STANDARD
Y101 TUNING FORK
C101 1MFD 35V DC
Q101 2N1248
R101 120K
R103 15K
R102 430K
C102 22MFD 35V DC
R105 18K
Q102 2N336
R106 10K
R107 390Ω
C104 35VDC 22MFD
R104 6.8K
C103 1MFD 35V DC
R109 82K
R108 18K
Q103 2N336
R112 3.3K
R110 180Ω
C106 22 MFD 35V DC
R111 750Ω
C105 1MFD 35V DC
CR101 1N1313
C107 2.2 MFD 35V DC
R115 68K
C108 1MFD 35V DC
R113 9.1K
R114 10K
Q104 2N336
C109 1MFD
R116 47K
R117 5.6K
B+
B-
OUTPUT
J3
R505 47K
C502 22MFD 35V DC
R504 47K
Q501 2N336
R501 10K
C501 22MFD 35V DC
R502 10K
R503 2.2K


UIT CARD
R222 27K
DENSITY M1
C207 8.2MFD 35V DC
R214 6.2K 1/4W
R213 180Ω
C208 1MFD 35V DC
R216 1.5K 1/4W
T203
CR201 IN2069
CR202 IN2069
R224 150Ω
R218 1.5K
C209 1.0MFD
R219 1.4Ω 3W
R220 5.6K
MANUAL PHASE S4
C3 12MFD 30V
CR2 IN2069
R2 120Ω 2W
L1 PHASING SOLENOID
R3 200Ω 5W
AUTO/MANUAL S2
AUTO
MANUAL
Q1 STC 1423
Q9 T1487
Q2 2N1423
FLI
IN
OUT
COM
R16 1K
Q5 2N1423
R5 1Ω 3W
R4 1/2Ω 3W
Q4 2N1423
Q6 2N1423
R6 1Ω 3W
R7 1Ω 3W
Q7 2N1423
MOTOR AMPLIFIER AND DRIVER PRINTED CIRCUIT CARD
B+
B-
J3
OUTPUT
R505 47K
C502 22MFD 35V DC
CR501 IN2985B
R506 150Ω 2W
T501
R504 4.7K
Q501 2N336
R501 10K
C501 22MFD 35V DC
R502 10K
R503 2.2K
DIVIDER M12
Q502 T1487
C504 22MFD 35V DC
R510 100Ω
C503 0.47MFD 35V DC
R508 10K
R507 2.7K
R511 220Ω
T502
R509 470Ω
Q503 T1487
C505 22MFD 35V DC
C506 22MFD 35V DC
R512 100Ω

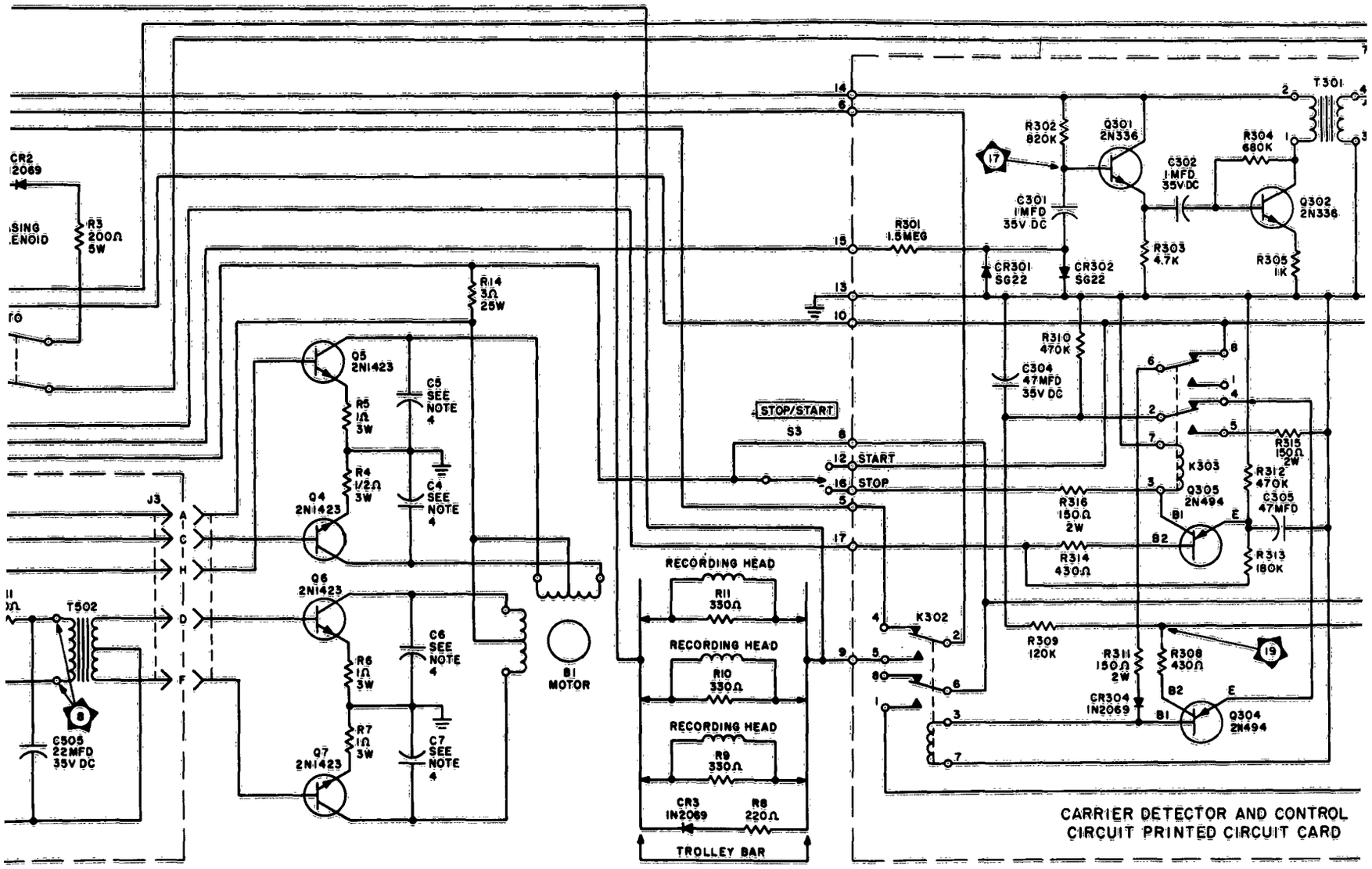


Figure 14. Carbon Paper Recorder R-1063( ), GX.

4

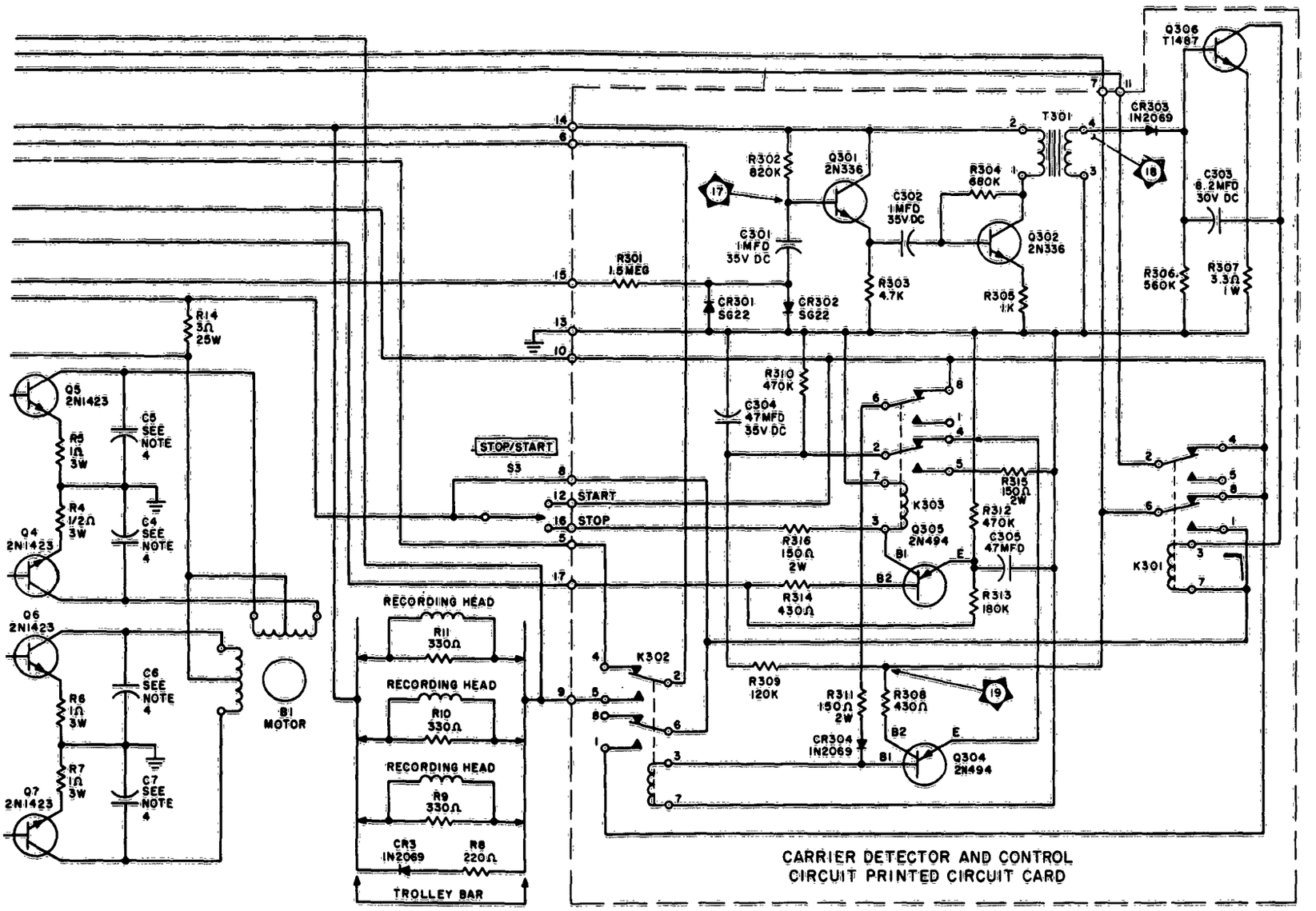


Figure 14. Carbon Paper Recorder R-1063( ), GX. Schematic Diagram

Table 1. Carbon Paper Recorder R-1063 ( )/GX Technical Specifications

Copy Size	Up to 8-1/2 x 11 in.
Intelligence Area	Same as transmitted copy
Recorded Materials	One roll of hard white paper and one roll of carbon paper.
Type of Recording	Pressure - Electromagnet.
Recording Speed	180/90 scans per min.
Resolution	96 lines per in.
Index of Cooperation	264 (IRE). (Modified type-264 or 576).
Power Source	115v, 60 cps.
Receiving Signal Level	-30 to 0 dbm. (0 dbm = 1mw/600-ohms).
Input Impedance	100K ohms.
Input Signal Carrier	2400 cps.
Weight	50 lbs.
Transistor Complement	22 Silicon Transistors (See table 2).

Table 2. Carbon Paper Recorder R-1063 ( ) GX, Transistor Complement

Transistor Type	2N336	2N494	T1487	2N1423	2N1248
Quantity	9	2	2	8	1

AD_____ Accession No. _____

Westrex Corporation, New York 19, New York

DEVELOPMENT OF A CONTINUOUS CARBON PAPER FACSIMILE RECORDER - Dr. H. Weisbecker.

Final Report, 17 January 1959 to 12 February 1963, 28 pp-illustrations, (Signal Corps Contract DA36-039 SC-78251), Unclassified Report.

The facsimile recorder is capable of reproducing copy sent from a remote point by accepting facsimile signals either from a telephone-line connection or from a radio receiver. For the latter mode of operation, a receiving converter is used. Power is supplied directly from a 115-volt, 60-cycle AC power line.

The recorder is identical in electronic circuit design and in method of recording to that developed under Signal Corps Contract No. DA36-039 SC-74836.

The recorder reproduces in under six (6) minutes an 8-1/2" by 11" sheet of copy. Detail is 0.01 inch. 180 lines per minute are recorded. The equipment is constructed with silicon transistors throughout. The copy is printed out by means of electro magnetic print heads applying pressure through a carbon overlay to white paper.

UNCLASSIFIED

1. A Continuous Carbon Paper Facsimile Recorder (Pressure recording).
2. Contract No. DA36-039 SC-78251

AD_____ Accession No. _____

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DEVELOPMENT OF A CONTINUOUS CARBON PAPER FACSIMILE RECORDER - Dr. H. Weisbecker.

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